Thinning inventory technique and its application in forest resource inventory

Luo Mingcan(罗明灿) Wang Lu (王 鲁)
Southwest Forestry College, Kunming 650224, P. R. China)

Klaus von Gadow
(Gottingen University, Germany)

Abstract A brief overview of the system of forest inventory in China and its problems existed is given. Forest planning requires information about the current state of the forest resource. However, generally speaking, the information collected in a periodic inventory may become obsolete already after the first thinning following. Therefore, in order to solve the problem, theory skeleton of thinning inventory technique and its approach in forest inventory, is presented in this paper, with an emphasis on the research and study developing currently thinning inventory.
Key words: Forest inventory, Thinning inventory, Inventory system

Introduction

Forest planning requires information about the current state of the forest resource. The most common stock-taking activities are stand based inventories scubas compartment sampling and systematic sampling schemes for forest strata involving plots. These classical stock-taking activities are scheduled to take place at periodic time intervals. With the abandonment of clearfelling, stand structure and complexities in the variables used to describe forest status have accordingly incurred changes, so new factors and techniques must be introduced and added to the previous system of forest inventory.

Forest inventory systems and existing problems in China

Forest inventory systems

For over 40 years, the researchers and workers in the field of forest inventory learnt the advanced technique from other countries, and through their effort constructed the forest inventory system which have its own characteristics. The system consists of 3 categories.

Nationwide forest inventory: This category of forest inventory provides continuous monitoring of forest resource and produces data at or over county level needed by national or provincial government in overall economic planning. This category includes inventory of forest area, timber stocking, forest type and the composition of various types as well as forest growth, regeneration, and felling operation.

Inventory for forestry planning and designing Also referred to as forest management inventory, the 2nd category provides forest resource at subcompartment level for forest farms or township administrative management departments in management planning. Besides data covered in the 1st category, this category also provides information on the physical conditions, history, economy and management of the study areas.

Inventory for production activities: Based on data from the 2nd category, this inventory provides concrete and detailed information for preparing annual production plan on the basis of felling area.

Existing problems

Discontinuity and impracticability

Almost all of the previous inventory systems are prepared only for some purposes and are carried out at irregular intervals in a variety of ways, and thus are in lack of continuity and uniformity in both standards and terms used. Information obtained at one time can not be compared very well with that at other times, and even information obtained at one time can not bear synchronological comparison due to differences in means of inventory. The results of each inventory only provide isolated data, which are not applicable to other situations and can not give continuous monitoring of the growth of forest stands.

Low systemization and modeling of inventory factors

Lacking spatial facts existed in the incomplete old system, which have made it difficult to conduct spatial analysis and apply automatic mapping technique.

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High cost and limited application of inventory results

Considerable input of manpower, material and finance is needed for each inventory, but the data obtained lost their usefulness shortly after the first thinning operation.

Forest resource assessment methods

Forest management and assessment require current information about forest state. The traditional method to obtain the information is to carry out the periodic inventory, which is scheduled to take place at periodic time intervals. The most common stock-taking activities are stand-based inventories such as compartment sampling and systematic sampling schemes for forest strata involving permanent plots (Fig.1)

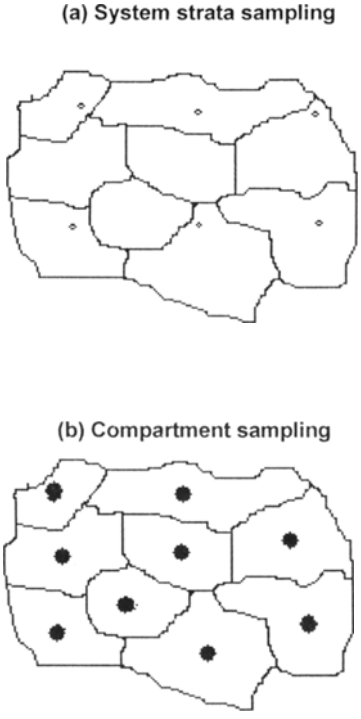

Fig. 1. Schematic representation of a systematic sampling scheme of forest status involving the entire management unit (a) or individual stands (b).

Systematic strata sampling using permanent plots

Many researches have show that the systematic strata sampling method rarely produces sufficiently accurate information for individual forest stands, even if the compartment area exceeds 30 hm^2. Furthermore, it is not possible to apply contemporary technique of automatic cartography and spatial analysis. The data obtained from systematic strata sampling cannot be used effectively in the geo-information system (GIS) which have become a major tool in the practice of forest planning. It is therefore not possible to do without standwide inventories. Systematic strata sampling with permanent plots require considerable investments. It is doubtful if the method is worth the money.

Periodic compartment inventories

A rather common method in the practice of forest resource assessment is the periodic compartment inventory. An advantage of the compartment inventory is the fact that the information obtained is spatially defined. The stand (or compartment) is a geographical unit for producing descriptions of current states and plans of future activities. It is an integral unit combing various levels of information in a relational database (Fig.2).

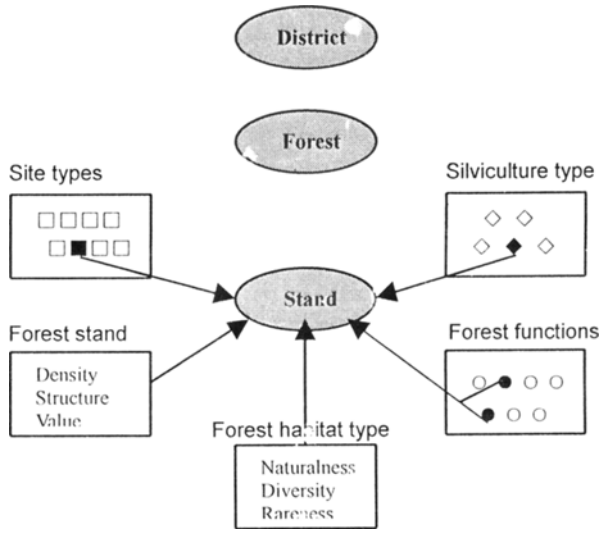

Fig. 2. The forest stand is the key for linking various tables in the data model of a forest management unit

Standwise inventories are becoming increasingly important as information technology is getting more sophisticated.

The disadvantage of a periodic inventory

Virtually all the current methods of forest sampling were designed for situation where the modification of stand structure following a thinning is assumed to be known. Stand inventories are carried out at regular intervals because the changes caused by thinning operation between successive inventories are assumed predictable. This is a plausible approach, as long as the actual silvicultural operations agree with the planned ones.

The data obtained in a periodic inventory are often very short-lived because of the changes resulting from intermediate thinning operation. The deficiency is not in the sampling design, but in the timing of the

enumeration activities. The most popular timing pattern is the regular one. In the traditional forest sampling schemes, periodic inventories are carried out in all stands at regular intervals. The values of the state variables assessed during an inventory change as a result of natural growth, but even more so as a result of thinning. So, to remedy the defect of the periodic inventory, a new approach is required.

Thinning inventories applied

In the traditional forest-sampling scheme, periodic inventories are carried out in all stands at regular intervals. The information gathered during a periodic stock taking would however become worthless after the first thinning as the forest state is changed by silviculture. The value of the state variables assessed during an inventory change as a result of thinning. Thus, despite the phenomenal progress, which has been achieved in the theory of forest sampling, there is no doubt that taking account of this simple fact may considerably enhance the effectiveness of forest inventory schemes.

Temporary plots in compartments

The information collected in a periodic inventory may become obsolete after the first thinning following the inventory. A different timing strategy is applied in an approach known as thinning inventory.

A thinning inventory captures stand data immediately after marking the trees, but before the marked trees are removed (Fig 3.). Using the same effort as a periodic inventory, a thinning inventory is capable of simultaneously producing information about three different states: i) all the trees before a thinning; ii) the removed trees; and iii) the trees remaining after the thinning.

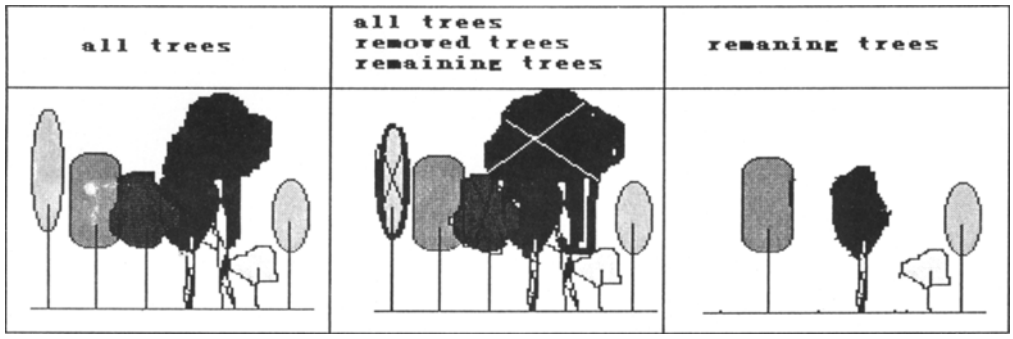

Fig. 3. Most resource inventories assess the entire growing stock (which may soon change due to a thinning operation, left) or on the growing stock remaining after a thinning (to evaluate the damage done by harvesting operation, right). Thus valuable information about thinning effects is forsaken; such information may be obtained in a thinning inventory (center).

Periodic inventories take place in all stands simultaneously at regular time intervals. Thinning inventory are carried out at the time of thinning, only in the stands that are modified by a thinning. They capture information about thinning effects, thus permitting data for modeling thinning effects and thinning behavior of individual foresters.

Permanent monitoring plots

The arguments in favor of standwise thinning inventories are also valid for permanent monitoring plots. Permanent plots are used to obtain rates of state variables. The interval between successive measurements should be sufficiently long enough to absorb the short-term effects of abnormal climatic extremes. The interval is a period of undisturbed growth and silvicultural operations are not permitted to take place between the two measurements. Measurements should coincide with a thinning operation, to obtain data not only about tree growth, but also at the same time about the change of state variable. The thinning effects may be assessed at the initial (t_1) or at the final (t_2) measurement, or at both occasions. The concept is illustrated by Fig. 4.

The data from a temporary thinning inventory provide the basis for continuous monitoring of silviculture, for modeling thinning effects and for estimating harvested products ahead if the harvesting operation. The data from the permanent monitoring plots are used to calibrate growth models.

Advantage of a thinning inventory

Many concepts of forest resource inventor include two types of plots, temporary plots for assessing current states and permanent plots for capturing change rates of state variable. Thinning inventory scheme, in contrast to a periodic one, obtains data on changes caused by natural processes and changes caused by management activity. Fig. 5 shows an example of inventory scheme (few, big) permanent

plots for calibrating growth models and temporary plots for continuous monitoring of silviculture.

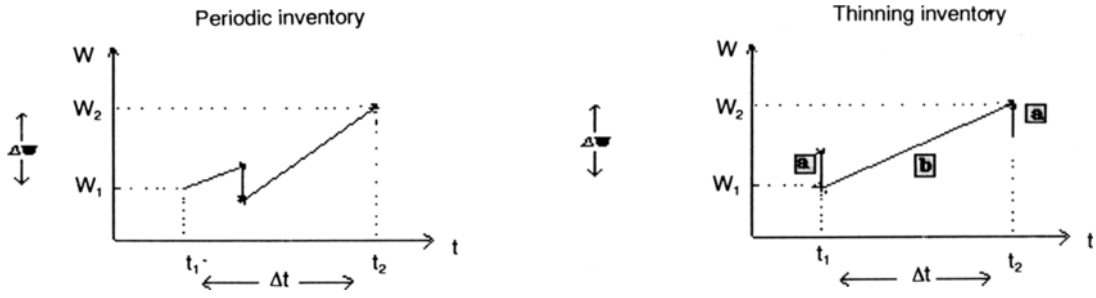

Fig. 4. Two successive measurements for obtaining the change of state variables.
Left: a periodic inventory where the thinning effects are unknown; right: a thinning inventory where two types of changes are assessed – the changes resulting from a) a thinning and b) natural growth.

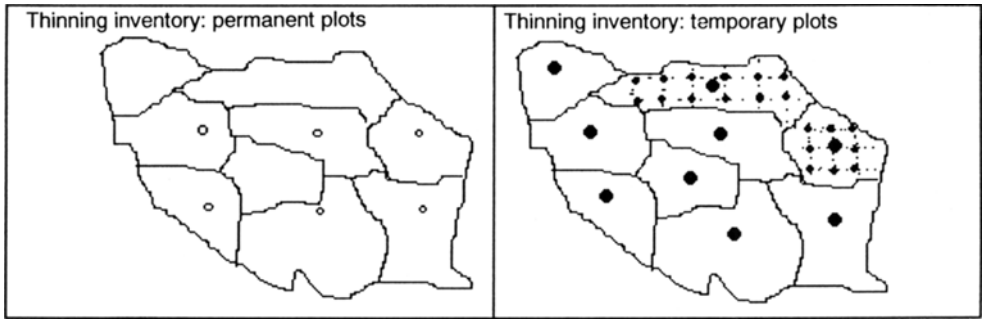

Fig. 5. Example of an inventory scheme using (few, big) permanent plots for calibrating growth models and temporary plots for continuous monitoring of silviculture
Both permanent and temporary plots were measured at the time of thinning (the large dots in the compartment s indicate plots for assessing administrative information, such as compartment areas).

Conclusions and suggestions

Thinning inventory technique is very effective to obtain current and accurate information for forest planning. It can remedy the defect of periodic inventory and provide the data for scientific forest management and compiling manage planning.

To introduce thinning inventory system into current inventory systems in China, and to develop scientific experimental research and study of the application of thinning inventory.

To add effective indicates to describe the spatial structure and state of the stands in forest resource inventory. The indicates for describing stands may be divided into two types, descriptive and normative. Descriptive indicates are used to describe a system state. Normative indicates are used to evaluate the condition of a system based on social, ethical or economic consideration. The traditional variables for describing a forest and projecting its development cover only part of the information required for planning. It is possible to improve considerably by introducing spatial variables, such as the differentiation of the breast height diameters (DBH) of neighboring trees and so on. The advantage of using structure variables with a spatial component is the potential to evaluate structure modification caused by thinning operation. It is possible, based on distribution of spatial defined variables, to generate theoretical stands with given characteristics. Obviously, to seek suitable spatial indicates applied in the evaluation for the stands are necessary.

To set up management information system based on thinning inventory in order to manage effectively forest resources.

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